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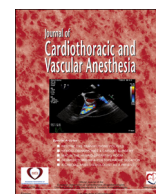
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Perioperative Echocardiography E-Challenges & Clinical Decisions

Severe Tricuspid Valve Injury During Right Ventricular Lead Extraction



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Key Words: clinical decision making; echocardiography; patent foramen ovale; lead extraction; right ventricular lead; implantable cardioverter-defibrillator; cardiac implantable electronic device (CIED); tricuspid valve; tricuspid regurgitation; right-to-left shunt; atrial shunt

A 67-YEAR-OLD MALE (height 183 cm, weight 100 kg) with a history of anterior myocardial infarction and cardiomyopathy (estimated ejection fraction of 20%-25%) presented for implantable cardioverter-defibrillator (ICD) lead extraction and single-chamber ICD reimplantation. At the time of presentation, his device was a single-chamber Medtronic Virtuoso ICD (Medtronic, Dublin, Ireland), which was implanted in 2007 for inducible ventricular tachycardia. The extraction was planned because the existing right ventricular (RV) Fidelis lead (Medtronic) had been placed on Food and Drug Administration advisory and the device battery was nearing elective replacement indications. His preoperative transthoracic echocardiogram showed severe regional left ventricular (LV) systolic dysfunction, with akinesis of the septum and severe hypokinesis of the mid-anterior wall and all distal LV segments. An apical LV aneurysm also was demonstrated on transthoracic echocardiography. The RV free wall displayed mild-to-moderate global hypokinesis. The

valvular structure and function were normal. The patient was scheduled for an elective lead extraction under general anesthesia with cardiopulmonary bypass as standby.

Intraoperative Echocardiographic Findings

After an uneventful induction of general anesthesia, the esophagus was intubated with a transesophageal echocardiography (TEE) probe, and an intraoperative echocardiographic examination was performed with an X7-2t probe and a Philips iE33 ultrasound system (Philips Ultrasound, Andover, MA). Of note, before lead extraction, the RV displayed moderate-to-severe global free wall hypokinesis (Video 1, A). The procedure proceeded uneventfully until after the RV lead extraction. An immediate postextraction TEE examination demonstrated a flail tricuspid valve (TV) leaflet (septal or anterior) (Fig 1; Video 2). There also was an eccentric tricuspid regurgitation (TR) jet of severe intensity (see Fig 1, C; Video 1, B), with abnormal leftward interatrial septal deviation suggestive of elevated right atrial (RA) pressure (Fig 2; Video 2). Global RV systolic function seemingly improved because of the severe TR (Video 1, B). In addition, color-flow Doppler demonstrated a simultaneous right-to-left shunt flow across the interatrial septum (Fig 3). This was

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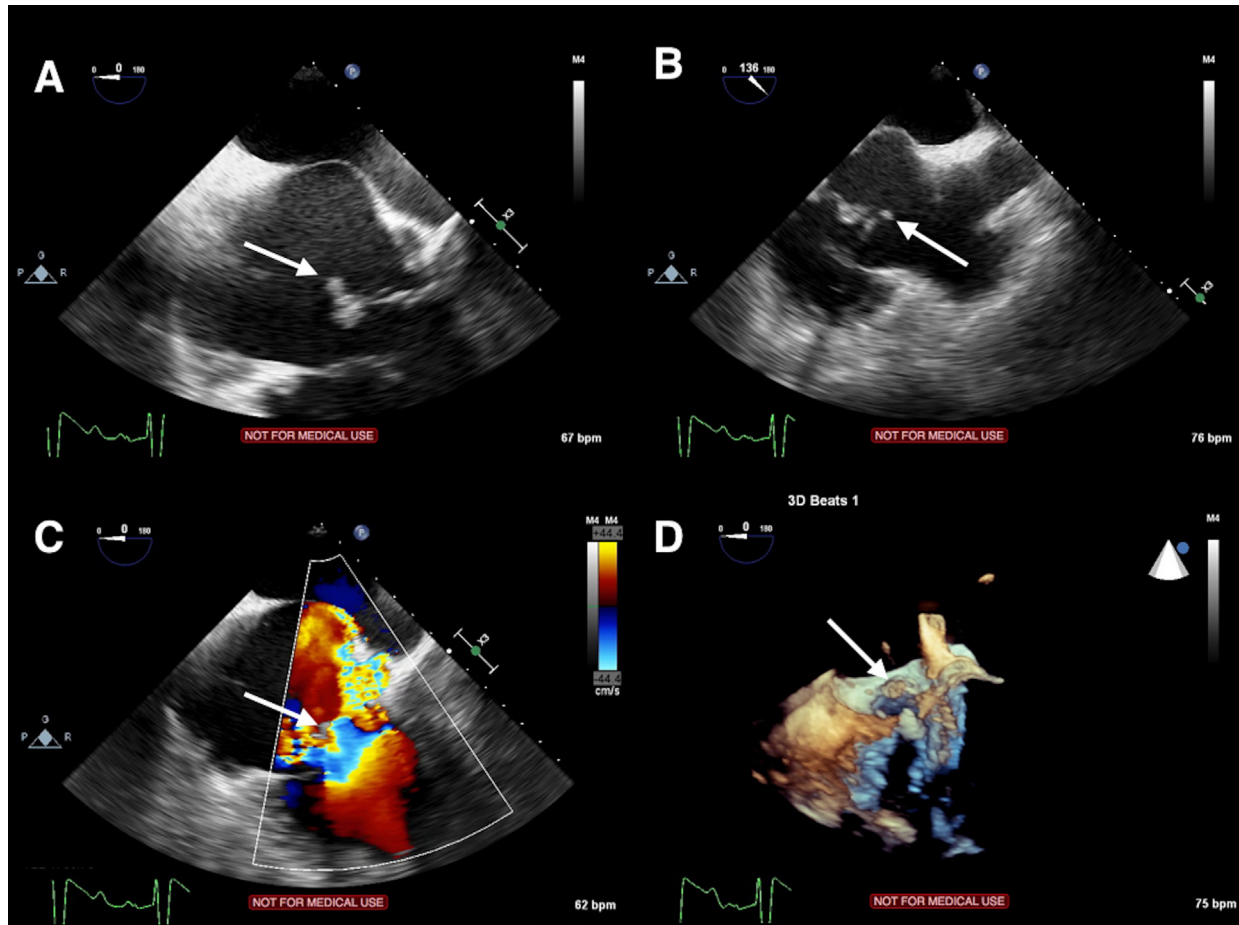


Fig 1. Intraoperative transesophageal echocardiography showing severe tricuspid regurgitation due to septal or anterior leaflet injury. Arrows indicate flail tricuspid valve (TV). (A) Midesophageal 4-chamber view. (B) Modified midesophageal TV view. (C) Midesophageal 4-chamber view and color-flow Doppler. (D) Live 3-dimensional mode showing flail TV.

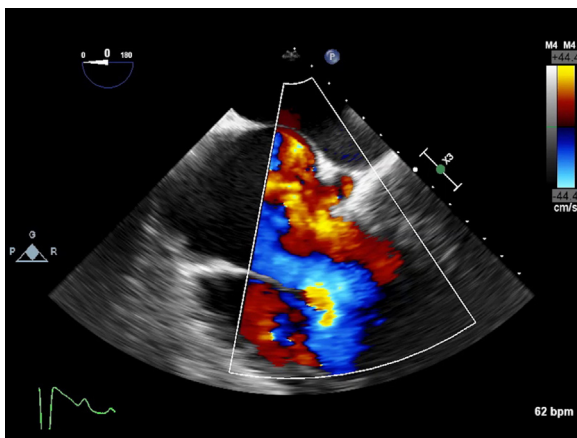


Fig 2. Intraoperative transesophageal echocardiography, midesophageal 4-chamber view. Diastolic septal motion toward the left atrium due to elevated right atrial pressure.

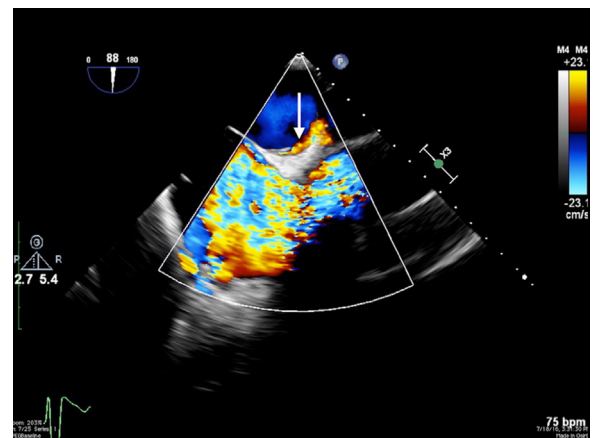


Fig 3. Midesophageal bicaval view. Right-to-left atrial shunt due to high right atrial pressure and patent foramen ovale. Flow detected on color Doppler indicated by arrow.

associated with transient mild hypoxia (oxygen saturation 92% on 40% $F_{I}O_2$). The patient also experienced transient hypotension

that responded to intermittent phenylephrine boluses (300 μ g) and an epinephrine infusion (0.03- μ g/kg/min).

Echocardiographic Challenges

The echocardiographic challenges were as follows:

- 1 Establishing the exact nature and severity of injury to the TV.
- 2 Accurately assessing the severity of TR.
- 3 Excluding other intracardiac injuries.

Clinical Challenges

The clinical challenges were as follows:

- 1 Does the TV injury require immediate intervention?
- 2 If immediate intervention is not necessary, what clinical course should be taken?

Clinical Course

The electrophysiology team was informed immediately of this new echocardiographic finding and its clinical sequelae. A complete TEE examination also was performed to exclude other intracardiac injuries. After exclusion of other intracardiac injuries and clinical stabilization of the patient, it was decided mutually to keep the patient's esophagus intubated for the time being and to monitor the course of the TR. The postoperative course was uneventful. The patient's esophagus was extubated 24 hours later, and the patient was discharged home after two days and scheduled for additional follow-up echocardiograms.

Discussion

After implantation, ICD leads and surrounding intracardiac structures usually go through fibrotic encapsulation by the activation of different humoral and cellular mechanisms.¹ Therefore, complications such as pericardial tamponade, RV rupture, vascular damage, pulmonary embolism, and TV injury can occur periodically.^{2–4} A high level of vigilance is required to detect and manage these possible complications during ICD extraction. Real-time TEE is an essential periprocedural imaging modality. Specifically, RV rupture can cause pericardial effusion and cardiac tamponade. The latter is a critical complication because it requires immediate intervention. Systolic RA or diastolic RV collapse and mitral valve inflow variation are used as diagnostic criteria. In the case of uncontrollable hemorrhage, RV repair is mandatory with cardiopulmonary bypass support. Disruption of the superior vena cava or brachiocephalic vein is a devastating complication because it results in immediate exsanguination in the thoracic cavity. Reconstruction with the patient under deep

hypothermic circulatory arrest (18–20° C) and antegrade cerebral perfusion usually are mandatory.

TV leaflet injury or elevated RV pressure due to pulmonary embolism can cause severe TR. A comprehensive echocardiographic valve analysis is essential when new-onset TR is diagnosed. Data regarding RV and pulmonary artery pressure, RV and RA dimensions, and RV systolic function need to be collected. However, life-threatening pulmonary embolism caused by vegetations derived from RV leads is rare.⁵ The management strategy for severe TR caused by TV injury is less well defined. Patients responsive to resuscitation are eligible for postprocedural stabilization before a decision for intervention is made. According to the American Heart Association/American College of Cardiology guidelines for management of valvular heart disease, the indication for TV replacement/repair is determined by the patient's symptoms and/or progression of RV dysfunction in the postoperative phase. Surgery in symptomatic patients can be beneficial if the patient's condition is unresponsive to conservative management; in asymptomatic patients with progressive deterioration of RV function, surgery may be considered (level of evidence C).⁶

In conclusion, the management of complications caused by lead extraction can be challenging and is highly dependent on the patient's condition. High-fidelity cardiac imaging using TEE is mandatory for quick and accurate diagnosis.

Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at <http://dx.doi.org/10.1053/j.jvca.2016.08.014>.

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